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IS 6297-1 (1971): Specification for Transformers and Inductors (Power, Audio, Pulse and Switching) for Electronic Equipment, Part I: General Requirements and Tests [LITD 5: Semiconductor and Other Electronic Components and Devices]

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Indian Standard

SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

(Fifth Reprint MARCH 1999)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 *March* 1972

Indian Standard
SPECIFICATION FOR
TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

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Indian Standard

SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 13 September 1971, after the draft finalized by the Transformers and Coils for Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The object of this standard is to establish uniform requirements for the electrical, mechanical and climatic properties and test methods for transformers and inductors (power, audio, pulse and switching) for electronic equipments.

0.3 This standard covers the general requirements and methods of measurements for transformers and inductors (power, audio, pulse and switching) for use in electronic equipment. Individual specification for different types of inductors and transformers, which shall cover the requirements appropriate to the type of the component, shall form other parts of the series of standard on transformers and inductors.

0.4 All the tests specified in this standard may not be applicable to all the different types of transformers and inductors. The relevant tests applicable and the values for different characteristics shall be specified in the relevant standard.

0.5 It is recognized that in the case of components like transformers and inductors, the performance requirements are related to the design of the particular circuit for which they are intended and it would, therefore, be difficult to lay down specific values for all characteristics independent of the equipment design. The intending purchaser should, therefore, furnish details of additional requirements of the component. A list of items for which the purchaser will have to specify the requirements shall be given in the relevant standard.

0.6 This standard lays down a single method of measurement for each characteristic so as to achieve the required degree of precision of measurement. It is, however, not intended to exclude other alternative methods of measurement for which necessary measuring equipment may be available and which are of equal or greater precision than the method prescribed in this standard.

0.7 This standard is largely based on the following specifications:

DEF 5214-1961 Transformers and inductors primarily intended for use in electronic equipment, issued by the Ministry of Defence, UK.

MIL C 15305C-1965 Coil, radio frequency and transformers, intermediate and radio frequency, general specification for, issued by the Department of Defence, USA.

MIL T 27B-1965 Transformer and inductor, audio and high power pulse, general specification for, issued by the Department of Defence, USA.

0.8 This standard requires reference to IS : 589-1961* so far as the details of the climatic and mechanical testing procedures are concerned; only the relevant degrees of severity have been specified in this standard.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers the general requirements and methods of test for judging the mechanical, electrical and climatic properties of inductors and transformers, such as power, audio, switching and pulse which are primarily intended for use in electronic equipment.

1.2 This does not cover multi-phase power transformers.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general qualities and design of a particular type of transformer or inductor.

2.2 Acceptance Tests — Tests carried out on samples selected from a lot for the purpose of acceptance of the lot.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

†Rules for rounding off numerical values (*revised*).

2.3 Lot — All components of the same type, category and rating, manufactured by the same factory during the same period, using the same process and materials.

2.4 Routine Tests — Tests carried out on each component to check the requirements which are likely to vary during production.

2.5 Type — A type comprises of products having similar functions, manufactured by the same techniques and falling within the manufacturer's usual range of ratings for these products.

NOTE 1 — Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 2 — Ratings cover the combination of

a) electrical ratings (*see* the relevant parts dealing with individual types of components),

b) sizes, and

c) environmental group.

NOTE 3 — The limits of the range of ratings shall be agreed to between the purchaser and the manufacturer.

3. CATEGORIES

3.1 The transformers and inductors shall be classified into the following three categories depending on their climatic severities:

Climatic Test (*see* IS : 589-1961*)	*Severity*		
	Category 1	Category 2	Category 3
Dry heat	+100°C	+85°C	+70°C
Cold	−55°C	−40°C	−10°C
Damp heat (long term)	56 days	56 days	21 days
Damp heat (accelerated)	6 cycles	6 cycles	2 cycles
Rapid change of temperature	+100°C to −55°C	+85°C to −40°C	Not applicable
Low air pressure	44 mbar	300 mbar	600 mbar

NOTE — In case of special requirements when the above categories cannot be applied strictly, other combinations of severity may be agreed to between the purchaser and the manufacturer provided such severities are chosen from IS : 589-1961*.

4. MATERIALS, CONSTRUCTION AND WORKMANSHIP

4.1 Materials — The components shall be constructed from materials free from flaws and other defects. As far as practicable, materials used for construction shall be non-flammable, non-explosive and non-corrosive.

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

4.2 Terminations — Components shall be provided with screw, lug, tag, leads or plug-in lead type terminations.

NOTE — Lugs, if used, shall be secured in such a way that they do not rotate or work loose or break away in normal use.

4.3 Nuts, Screws and Washers — All nuts, screws and washers, including lock washers used in the construction of transformers and inductors shall be of standard sizes and threads (*see* IS : 4218-1968*).

4.4 Finish — All exposed metal parts such as edges of laminations, brackets and other hardware shall be plated, painted or otherwise protected to prevent corrosion.

4.5 Workmanship — All parts of the components shall be manufactured in a thoroughly workmanlike manner and in accordance with good engineering practice.

5. MARKING

5.1 Each component shall be clearly and indelibly marked with the following:

a) Manufacturer's name or trade-mark,

b) Manufacturer's code number.

c) Terminal identification, and

NOTE — Any additional marking if needed by the relevant specification shall also be marked.

d) Any other marking such as batch number as agreed to between the customer and the manufacturer.

6. TESTS

6.1 General Conditions for Tests

6.1.1 *General* — Tests shall be carried out on the components as received from the manufacturer or supplier.

6.1.2 *Atmospheric Conditions for Testing* — Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions specified in IS : 589-1961†.

6.1.3 *Preconditioning* — Before measurements are made the components shall be stored at the measuring temperature and relative humidity for a time sufficient to allow the entire component to reach these conditions. The recovery period called for after conditioning is adequate for this purpose.

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*ISO metric screw threads (in six parts).

†Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

6.1.4 *Correction to be Applied* — When measurements are made at an ambient temperature other than the reference temperature, the results shall, where necessary, be corrected to the reference temperature. The ambient temperature during the test shall be stated in the test report.

6.1.5 *Other Precautions* — During measurements the components shall not be exposed to draughts, direct sun-rays or other influences likely to cause errors.

6.1.6 *Classification of Tests*

6.1.6.1 *Type tests* — The procedure for type approval shall be in accordance with IS : 2612-1965*.

Number of samples — The number of samples for type tests shall be 15 of same code number unless otherwise specified by the relevant specification.

Sequence of type tests — The sequence of type tests shall be in accordance with Appendix A unless otherwise specified in the relevant specification.

6.1.6.2 *Acceptance tests* — The acceptance tests shall be carried out on a limited number of samples selected in accordance with the sampling procedure given in IS : 2612-1965* and which have passed the routine tests.

Two groups of samples, one for non-destructive tests and the other for destructive tests, shall be selected and each group shall be subjected to the tests specified in the relevant specification.

6.1.6.3 *Routine tests* — These shall be as specified in the relevant specification.

6.2 Electrical Tests

6.2.1 *General Tests*

6.2.1.1 *Continuity of winding* — Each winding of the component shall be tested for electrical continuity by any suitable method. Each winding shall be continuous.

6.2.1.2 *DC resistance of winding* — The component shall be maintained under normal atmospheric conditions and the resistance of each winding shall be measured, the ambient temperature being simultaneously recorded. Unless otherwise specified the value shall be referred to the temperature of 27°C and this value shall be within the tolerance limits specified in the relevant specification.

6.2.1.3 *Polarity* — Where applicable, the polarity shall be checked by any convenient method. The polarity shall be as specified in the relevant specification.

---

*Recommendation for type approval and sampling procedure for electronic components.

6.2.1.4 *Shielding (where applicable)*

a) *Electrostatic shielding* — The object of this test is to check the effectiveness of the electrostatic shielding between two sets of windings of a transformer. The effect of electrostatic shielding is expressed as a ratio of two voltages — V_1 (without the screen earthed) and V_2 (with the screen earthed) — applied across one set of windings for the same voltage developed across the other set of windings (*see* Fig. 1).

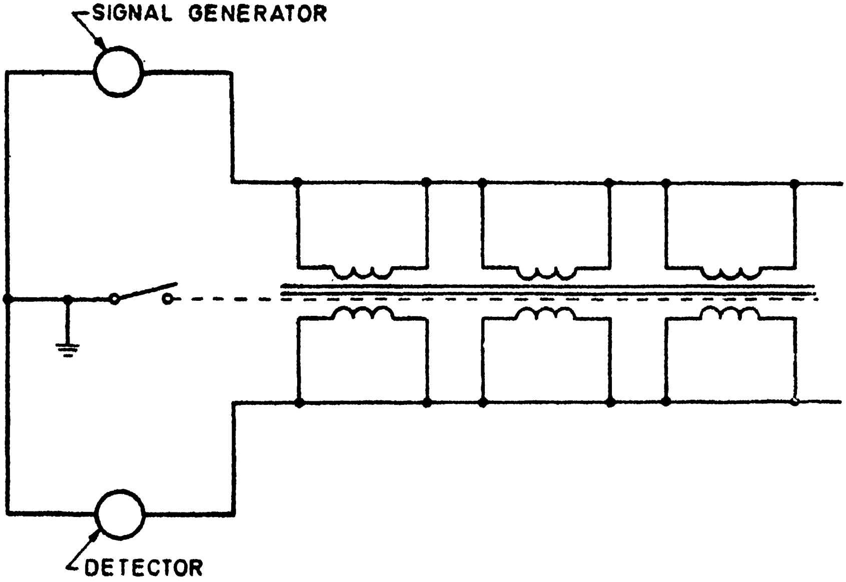

FIG. 1 ELECTROSTATIC SHIELDING TEST CIRCUIT

The core and case of the transformer shall be earthed. All the windings of the same side of the shield shall be short-circuited and connected together. For the measurement of V_1 the screen shall not be earthed. An ac voltage at 1 000 Hz shall be applied between earth and one group of windings and the voltage developed between earth and other group of windings shall be measured by a suitable sensitive device. For the measurement of V_2, the screen shall be earthed and the applied voltage across one group of windings and earth shall be varied such that the same voltage is developed across the other group of windings and earth as in the case of measurement of V_1. The ratio of V_1/V_2 shall be as specified in the relevant specification.

b) *Magnetic shielding* — The component shall be placed at the centre of a test coil consisting of 1 500 turns of wire of diameter 0·315 mm wound on a former of 30 cm diameter and 2·5 cm width. A voltage of 240 V, 50 Hz is applied to the test coil. The component shall be so oriented as to give the maximum voltage pick-up. The voltage developed across the winding giving the largest reading shall be measured with an electronic voltmeter. The pick-up voltage shall not exceed the value specified in the relevant specification.

6.2.1.5 *Temperature-rise* — This test shall be carried out at a temperature not exceeding the upper category temperature. The component shall be mounted so as to be protected from draughts and shall not be subjected to radiations from warmer objects. The thermometer (which may be of thermocouple type) used for measuring the ambient temperature shall be protected against trivial temperature changes by means of an oil bath or any other suitable thermal delay device.

The cold resistance of the winding shall be measured after conditioning the component for at least 8 hours until three consecutive temperature readings taken at 30-minute interval are constant and this constant temperature shall be taken as the reference temperature T_1.

All the secondary windings shall be terminated with their specified loads so that the rated currents are flowing through them at the rated voltages. After the load has been connected as specified, the transformer shall be operated continuously for a period of 6 hours at the specified frequency and at 110 percent of the rated input power. The input voltages shall be adjusted to maintain constant loading. The hot resistance of the winding shall be measured within one minute after the completion of the test run.

The temperature-rise of the transformer shall be computed by subtracting the temperature of the ambient air (T_1) around the transformer from the temperature of the hottest winding (T_2) using the formula:

$$\frac{R_1}{R_2} = \frac{1 + \alpha T_1}{1 + \alpha T_2}$$

where

α = temperature coefficient of the material of the winding wire,

R_1 = dc resistance at T_1°C, and

R_2 = dc resistance at T_2°C.

The temperature-rise shall not exceed the value stated in the relevant specification.

Note — The temperature-rise of any winding or section shall not exceed the value ($X - Y$), where X is the temperature corresponding to the class of the insulation (*see* IS : 1271-1958*) after allowing for hot spot temperature and Y is the upper category temperature.

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*Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.

6.2.1.6 *Insulation resistance* — This test shall be carried out after the temperature-rise test. Unless otherwise specified, the insulation resistance shall be measured by applying dc test voltages as mentioned below for one minute ± 5 seconds between the case and each winding and also between windings, if applicable. The voltage shall not be applied gradually but shall be applied immediately through the internal resistance of the test apparatus. The insulation resistance shall be read after 1 minute ± 5 seconds.

Maximum working voltage in volts	*Test voltage in volts*
25 and below	100
Above 25	500

The insulation resistance shall conform to the specified value in the relevant specification. The values obtained shall not be less than those specified in the relevant specification.

6.2.1.7 *Voltage proof* (*high voltage*) — The transformer or inductor shall withstand without breakdown the application of an ac test voltage of value shown as under:

Maximum working voltage in volts	*Test voltage in volts*
25 and below	100
Above 25	$2U_R + 1\,500$

The test voltage shall be applied between windings and the case, if any. In case of single winding inductor and insulated types of inductors and transformers the voltage is to be applied between a metal foil which is closely wrapped around the component and the windings. The voltage shall be raised at a rate not exceeding 500 V per second and shall be maintained at the maximum value for one minute. All windings not under test shall be connected to the case.

When this test is carried out as a routine test, the voltage shall be applied for one second only.

6.2.2 *Tests Applicable to Power Transformers*

6.2.2.1 *No-load test* [*no-load current and no-load power* (*magnetizing and core loss*)] — The primary no-load current and no-load power shall be measured at the voltage and frequency specified in the relevant specification with suitable measuring devices. The values measured shall not exceed the values stated in the relevant specification.

6.2.2.2 *Secondary no-load voltages and primary tap voltages* — The rated voltage at the rated frequency or frequencies shall be applied to the primary winding with the secondary or secondaries open-circuited. The open-circuit voltage developed across each secondary winding shall be measured. The values of the secondary voltages recorded shall be within ± 2·5 percent for voltages less than 100 V and ±5 percent for voltages greater than 100 V unless otherwise specified in the relevant specification.

In the case of primary tapped transformers, the secondary voltages at other tappings of the primary shall also be checked.

6.2.2.3 *Efficiency* — For power transformers having a gross core section greater than 1·6 cm², the efficiency shall be calculated from measurements of the input and output made during the temperature-rise test.

The efficiency shall not be less than 80 percent unless otherwise specified in the relevant specification.

6.2.2.4 *Voltage regulation* — The rated voltage at the rated frequency or frequencies shall be applied to the primary winding with the secondary or secondaries open-circuited. The open-circuit voltage developed across the secondary winding under test shall be measured. This secondary winding shall then be terminated with the specified load while the other secondary windings are kept open-circuited. The voltage developed across the terminated secondary winding shall be measured. Regulation shall be calculated from these measurements for each secondary winding. The value shall not be lower than that specified in the relevant specification.

6.2.2.5 *Induced high voltage* — For ac rating of 50 V rms and above, twice the rated voltage at not less than twice the nominal rated or ripple frequency, shall be applied across the primary of the transformer or inductor winding, any other winding being open-circuited. Windings having graded insulation shall have the nominal working voltage applied to the low potential end. The voltage shall be raised from one-third of the maximum value to full value as rapidly as is consistent with accurate reading of the indicating instrument. The full test voltage shall be maintained for one minute and shall then be rapidly reduced to one third of the value before being switched off. At the end of the test the component shall be tested for the following:

a) *Insulation resistance* (*see* **6.2.1.6**) — There shall be no change from the values obtained in **6.2.1.6**.

b) *No load current* — (*see* **6.2.2.1**) — The value shall not be more than those specified.

6.2.3 *Tests Applicable to AF Transformers and AF Inductors*

6.2.3.1 *Inductance and ac resistance* (*where specified*)

(a) *Without dc polarisation* — For components without dc polarisation, the inductance (L) and ac resistance shall be measured at the specified frequency and voltage.

(b) *With dc polarisation* — For components with dc polarisation, the inductance (L) and ac resistance shall be measured with the specified dc applied and at the specified frequency and voltage.

The values of the inductance and ac resistance shall be as specified in the relevant specification.

6.2.3.2 *Inductive unbalance* — The inductance of each portion of the winding shall be measured at the specified test voltage and frequency with the specified dc, if any, applied in accordance with **6.2.3.1**. The inductive unbalance of centre tapped windings in percentage shall be computed from the following formula:

$$\text{Inductive unbalance} = 2\left[\frac{L_1 \sim L_2}{L_1 + L_2}\right] \times 100$$

where

L_1 and L_2 are inductances of each part of the winding

The values shall be within the limits specified.

6.2.3.3 *Turns-ratio* — The turns-ratio of the transformer shall be computed from the ratio of voltages measured across the required winding with the secondary open-circuited and the measurement being done with a high impedance voltmeter.

6.2.3.4 *Reflected load-impedance* — Any one secondary winding of the AF transformer shall be terminated with a non-inductive resistance numerically equal to its specified load impedance, other windings being kept open-circuited. If the transformer is designed to work with more than one secondary winding loaded simultaneously, it shall be loaded as such, for this test. Reflected load impedance of the primary winding shall be measured by a bridge or an equivalent method, at a specified test voltage and test frequency when the rated dc current, if any, is flowing in the winding. The impedance thus measured shall be as specified.

6.2.3.5 *Frequency response* — Any one secondary winding of the AF transformer shall be terminated with a non-inductive resistance numerically equal to its specified load impedance at 1 000 Hz, other windings being kept open-circuited. If the transformer is designed to work with more than one secondary winding loaded simultaneously, it shall be loaded as such for this test. A resistance equal to the reflected load impedance at 1 000 Hz shall be connected in series with the primary winding. A low impedance source of adequate power with variable frequency and voltage shall be connected in series with the circuit comprising the primary winding and the series resistance.

The set up as given in Fig. 2 shall be used for this test.

At 1 000 Hz and with all normal dc currents, if any, flowing the power of the source shall be varied until the input power to the transformer is of the specified value. The voltage across the combination of the series resistance and the transformer primary winding shall then be noted and held constant as the frequency of the source is varied. At each frequency, the voltage across the secondary winding shall be measured using a high impedance voltmeter like electronic voltmeter. The frequency response at any frequency f shall be determined by calculating for that frequency, the value of

$$20 \log \frac{E_n}{10 E_0}$$

where

E_n = voltage across the winding at frequency f, and

E_0 = voltage across the secondary winding at 1 000 Hz.

The data obtained may be plotted as a function of frequency. The voltage-frequency response curve shall be within the limits specified with respect to the value at 1 000 Hz for a given frequency range.

NOTE — For certain types of transformers such as modulation transformers, the secondary winding may have to be terminated with the specified load impedance instead of the resistance equal to the load impedance at 1 000 Hz. The relevant specification should specify whether the secondary winding of the transformer is to be terminated with load impedance and if so the details of the load impedance also should be specified.

6.2.3.6 *Harmonic distortion* — The measurement set-up is shown in Fig. 2. Any one secondary winding of the transformer shall be terminated with a non-inductive resistance numerically equal to its specified load impedance at 1 000 Hz, other windings being kept open-circuited. A resistance equal to the normal reflected load impedance at 1 000 Hz shall be connected in series with the primary winding. If the transformer is designed to work with more than one secondary winding loaded simultaneously, it shall be loaded as such for this test. A low impedance source of adequate power with variable frequency and voltage shall be connected in series with the circuit comprising of the primary winding and the series resistance. The distortion content of the power source shall not exceed 25 percent of the specified maximum allowable distortion for that transformer.

At 1 000 Hz and with all normal dc currents, if any, flowing, the power of the source shall be varied until the input to the transformer is of the specified value. The distortion across each secondary load shall be measured with the help of a distortion-factor meter, either at 1 000 Hz or at any other specified frequency under rated conditions. The distortion shall be expressed as the percentage of the total output voltage and shall be within the limits specified in the relevant specification.

NOTE — For certain types of transformers such as modulation transformers, the secondary winding may have to be terminated with the specified load impedance instead of the resistance equal to the load impedance at 1 000 Hz. The relevant specification should specify whether the secondary winding of the transformer is to be terminated with load impedance and if so the details of the load impedance also should be specified.

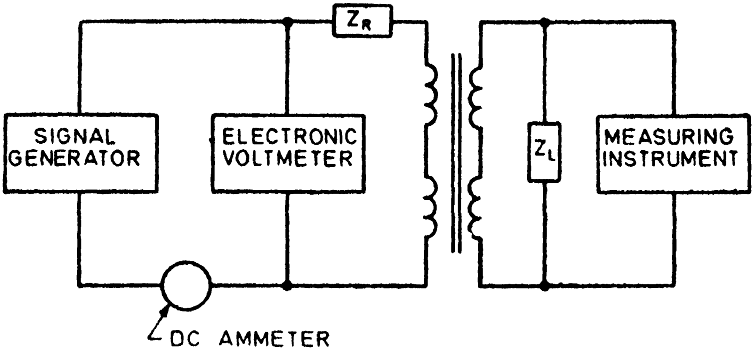

FIG. 2 MEASUREMENT SET-UP FOR HARMONIC DISTORTION

6.2.3.7 *Power handling capacity* — The power handling capacity shall be measured along with the measurement of distortion with the set-up specified in Fig. 2.

With the specified dc currents, if any, flowing, the ac voltage applied to the primary winding shall be increased until the measured distortion percentage corresponds to the maximum permissible value for the particular transformer. The input power shall then be calculated from the formula:

$$\text{Input power} = \frac{V^2}{R}$$

where

V = voltage across the primary winding, and

R = reflected load impedance as determined in **6.2.3.4**.

6.2.3.8 *Insertion loss* — The measurement set-up is shown in Fig. 3. With the specified source emf, source impedance and load impedance, the output voltage across the secondary load shall be measured at the specified frequency. The insertion loss in decibels shall be determined in accordance with the following formula:

$$\text{Insertion loss in dB} = 10 \log \frac{E_s^2 Z_L}{4 V_o^2 Z_s}$$

where

E_s = source emf,

Z_L = load impedance,

V_o = output voltage, and

Z_s = source impedance.

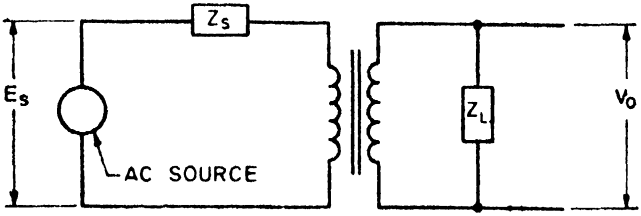

FIG. 3 CIRCUIT FOR INSERTION LOSS MEASUREMENT

The requirement shall be in accordance with the value stated in the relevant specification.

6.2.3.9 *Phase shift* — The object of this test is to measure the phase shift in electrical degrees between the primary and secondary voltages of the transformer. The measurement may be made by using a phase-meter of accuracy better than 10 percent of the permissible limits of phase shift specified for the particular transformer.

6.2.4 *Tests Applicable to Pulse Transformers*

6.2.4.1 *Turns-ratio* — The turns-ratio shall be measured in accordance with **6.2.3.3** and it shall be in accordance with the requirements stated in the relevant specification.

6.2.4.2 *Natural resonant frequency* — During this test, the input voltage shall be kept constant. The pulse transformer is connected in series with a variable frequency generator. The secondary or secondaries shall be terminated with specified non-inductive loads. The frequency of the input voltage shall be varied over the specified range. At each frequency, the voltage across the secondary winding shall be measured using a high impedance voltmeter like electronic voltmeter. The resonant frequency which will be indicated by a dip in the secondary voltage shall be recorded if it occurs within the specified frequency range.

6.2.4.3 *Pulse shape* — While conducting the temperature-rise test (*see* **6.2.1.5**), the shape of the output pulse shall be viewed on the cathode ray oscilloscope. The requirements of the pulse shape as stated in the relevant specification shall be met.

6.2.4.4 *Rise time* — The rise time shall be computed from the wave shape obtained in the oscilloscope (*see* **6.2.4.3**).

6.2.4.5 *Inductance under pulse magnetisation conditions* (*or effective pulse open-circuit inductance*) — The inductance of each winding of the transformer shall be measured at the specified polarising dc and at specified pulse magnetising conditions. The measured value shall be within the stipulated limits.

6.2.5 *Tests Applicable to Switching Transformers*

6.2.5.1 *General* — The switching transformer shall be tested as part of the application circuit and it shall operate satisfactorily by delivering the correct voltages at the switching frequency and efficiency limits as specified in the relevant specification.

6.2.5.2 *Primary inductance* — The inductance of the primary winding shall be measured at the switching frequency and voltage it shall support. The value shall be as stated in the relevant specification.

6.2.5.3 *Turns-ratio* — The turns-ratio shall be measured in accordance with the procedure indicated in **6.2.3.3** and the requirements stated in the relevant specification shall be met.

6.2.5.4 *Leakage inductance* — The leakage inductance of each winding shall be measured by shorting the other winding at the specified test voltage and test frequency. The value so obtained shall remain within the values stipulated.

6.3 Physical and Mechanical Tests

6.3.0 Any electrical test after the mechanical tests if deemed necessary, shall be indicated in the relevant specification.

6.3.1 *Visual Examination* — The components shall be visually examined for workmanship, finish, condition and marking and these shall be satisfactory.

6.3.2 *Dimensions* — The dimensions of the component shall be checked and conform to the dimensions in the relevant specification in case they have been prescribed in it.

6.3.3 *Robustness of Terminations*

6.3.3.1 *Tensile test on all terminations* — All terminations shall be subjected to the test in accordance with **7.19.1** of IS : 589-1961[*]. The loading weight, the duration of the test and the number of bends shall be as specified in the relevant specification. In the case of tag terminations, the tests shall be carried out in accordance with **7.19.2.3** of IS : 589-1961[*].

6.3.3.2 *Torsion test (applicable for components with screw terminations)* — This test shall be carried out in accordance with **7.19.4** of IS : 589-1961[*]. Components shall withstand the torsion as specified in the relevant specification.

There shall be no sign of fracture, loosening of parts or any other mechanical failure. The continuity of all windings shall be checked after the tensile and the torsion tests.

6.3.4 *Soldering* — Transformers provided with tag and lead type terminations shall be subjected to solder bath test in accordance with **7.18.2** of

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[*] Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

IS : 589-1961*. The period of recovery after the immersion of the termination shall be 30 minutes, unless otherwise specified in the relevant specification.

At the end of the test, the component shall be visually examined. The component shall not show any loosening of connections, melting or seepage of sealing material or any other deterioration. The continuity of all the windings shall be checked.

6.3.5 *Hermetic Sealing* — In the case of hermetically sealed components, they shall be subjected to test A or B or C or as indicated in the relevant specification in accordance with **7.16** of IS : 589-1961*. There shall not be any leakage or liquid penetration in the component.

6.3.6 *Bump* — The component shall be mounted as specified in **7.5.1.6** of IS : 589-1961*, taking care that the terminations are not stressed and that equal number of samples are bumped in each of the three principal axes. Samples shall be subjected to bump test in accordance with **7.5.1** of IS : 589-1961*. After the test, the component shall be visually examined and shall not show any damage or deterioration.

The continuity of the winding shall be checked. The inductance of the component shall be measured if called for and shall conform to the value specified in the relevant specification. There shall be no change in the insulation resistance when measured after this test.

6.3.7 *Vibration* — The component shall be mounted as required in **6.3.6** so that equal number of samples are vibrated along each of the three principal axes. The component shall be subjected to vibration (fatigue) test in accordance with **7.6.6** of IS : 589-1961*.

After the test, the component shall be visually examined and there shall not be any damage or deterioration. The continuity of the winding shall be checked. The inductance shall be measured and shall conform to the specified values. There shall be no change in insulation resistance when measured at the end of this test.

6.3.8 *Acceleration* — The component shall be mounted suitably and shall be subjected to a linear acceleration of 100 g unless otherwise specified in the relevant specification.

The component, mounted as specified, shall be subjected to 5 minutes acceleration of the appropriate severity in each plane and sense so that each component is accelerated for a total period of 30 minutes unless otherwise specified in the relevant specification. During the test the component shall be loaded as required by the relevant specification.

At the conclusion of the test, the components shall be visually examined. There shall be no seepage of impregnant, loosening of parts or other mechanical damage. Continuity of each winding shall be checked.

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The insulation resistance shall be measured. There shall be no change when compared with the value obtained in **6.2.1.6**.

6.3.9 *Shock* — The component shall be subjected to shock test in accordance with **7.5.2** of IS : 589-1961*. The severity and the duration of the test shall be as indicated in the relevant specification. At the conclusion of the test, the components shall be visually examined and checked for continuity of windings and insulation resistance. There shall be no seepage of impregnant, loosening of parts or other mechanical damage and the winding shall be continuous. There shall be no change in the insulation resistance value as compared to **6.2.1.6**.

6.4 Climatic Tests

6.4.1 *Climatic Sequence*

6.4.1.1 *Dry heat* — The component shall be subjected to the dry heat test in accordance with **7.2** of IS : 589-1961*. The temperature of the test chamber shall be maintained at the maximum category temperature of the component. The component shall be on full load during the exposure if specified in the relevant specification. While still at the high temperature and during the last half hour of exposure, the insulation resistance shall be measured and shall be not less than the value specified in the relevant specification.

After recovery, the component shall be visually examined for any damage or deterioration. The insulation resistance shall be measured as in **6.2.1.6** and it shall not deviate from the values obtained therein.

6.4.1.2 *Damp heat* (*accelerated*) (*first cycle*) — The component shall be subjected to the first cycle of the damp heat (accelerated) test in accordance with **7.4** of IS : 589-1961*. The duration of the recovery period shall be one and a half hours. After recovery, the component shall be visually examined for any damage or deterioration.

6.4.1.3 *Cold test* — The component shall be subjected to the cold test in accordance with **7.1** of IS : 589-1961*. The temperature of the chamber shall be maintained at the minimum category temperature of the component. The duration of recovery period shall be one and a half hours. After recovery, the component shall be visually examined. The following tests shall be carried out:

a) Continuity of the winding,
b) Voltage proof, and
c) Insulation resistance.

6.4.1.4 *Low air pressure* — The component shall be subjected to low air pressure test in accordance with **7.12** of IS : 589-1961*. The pressure shall be appropriate to the category and the duration shall be 5 minutes.

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During the period of exposure, a test voltage equal to 120 percent of the working voltage shall be applied across the component:

a) For transformers, all secondary windings shall be kept open-circuited, and
b) If any winding(s) of the transformer is (are) specified for working with dc or ac voltage between it (them) and the core, case or other windings, 120 percent of this voltage shall be applied between the windings and other appropriate points.

There shall be no electrical failure or mechanical deterioration.

6.4.1.5 *Damp heat (accelerated) (remaining cycles)* — The component shall be subjected to the remaining number of cycles of damp heat (accelerated) in accordance with **7.4** of IS : 589-1961*. After the recovery of 1½ to 2 hours for categories 1 and 2 components and 24 hours for category 3 components, the components shall be subjected to visual examination and the continuity of windings is tested. There shall be not any apparent damage or illegibility of markings and the windings shall be continuous. The no-load current shall also be checked.

The components shall then be subjected to insulation resistance test (*see* **6.2.1.6**). The values shall not be less than those specified in the relevant specification.

6.4.2 *Damp Heat (Long Term Exposure)* — The components shall be subjected to the damp heat (long term exposure) test in accordance with **7.3** of IS : 589-1961*. The duration of the exposure shall be in accordance with the category of the component under test.

During the test, loading if required, shall be specified in the relevant specification. After recovery, the components shall be subjected to visual examination and the continuity of windings is tested. There shall be not any apparent damage. The markings shall be legible and the windings shall be continuous. No-load current shall also be checked.

The components shall then be subjected to insulation resistance test (*see* **6.2.1.6**). The values shall not be less than those specified in the relevant specification.

6.4.3 *Rapid Change of Temperature* — The component shall be subjected to rapid change of temperature test in accordance with **7.14** of IS : 589-1961*. The number of cycles shall be one unless otherwise specified in the relevant specification.

After recovery, the components shall be subjected to visual examination and the continuity of windings is tested. There shall be not any apparent damage, the markings shall be legible and the windings shall be continuous.

The components shall then be subjected to insulation resistance test. The values shall not be less than those specified in the relevant specification.

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6.5 Salt Mist — The component shall be subjected to salt mist test in accordance with **7.10** of IS : 589-1961*. The duration of exposure shall be 4 days. After cleaning and recovery, the component shall be subjected to visual examination and the continuity of windings shall be tested. There shall be not any apparent damage, the markings shall be legible and the windings shall be continuous.

The components shall then be subjected to insulation resistance test. The values shall not be less than those specified in the relevant specification.

6.6 Mould Growth — The component shall be subjected to mould growth test in accordance with **7.9** of IS : 589-1961*. At the end of the test the components shall be subjected to visual examination and the continuity of windings shall be tested. There shall be not any apparent damage, markings shall be legible and the windings shall be continuous.

The components shall then be subjected to insulation resistance test. The values shall not be less than those specified in the relevant specification.

6.7 Storage — Component shall be subjected to storage test in accordance with **7.8.1** of IS : 589-1961*. The component intended to be used as a sealed unit in an equipment shall be stored in a packing as supplied. At the end of every three months of storage, the component shall be examined for the following:

a) *Winding resistance* — The change from the value recorded in **6.2.1.2** shall not exceed 10 percent.

b) *Insulation resistance* — The values shall not be less than those specified in the relevant specification.

c) *Voltage proof* (*see* **6.2.1.7**) — There shall be no breakdown or deterioration.

6.8 Endurance — The component shall be operated at the maximum category temperature for the rated voltage and frequency for 2 000 hours unless otherwise specified in the relevant specification. The loads shall be those for which the component is designed. If the primary has tappings, the nominal voltage of the tapping shall be applied to the lowest voltage range. After completion of the specified duration of operation, the transformer or inductor shall be exposed to recovery conditions for 24 hours and shall then be subjected to the following tests:

a) *Visual examination* — There shall be no deterioration so as to impair operations and the markings shall be legible.

b) *Winding resistance* — The change from the value recorded in **6.2.1.2** shall not exceed 10 percent.

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c) *Insulation resistance* — The values shall not be less than those specified in the relevant specification.

Note — Any other electrical test after the climatic tests, if deemed necessary, shall be indicated with the requirements in the relevant specification. In case of sealed components, the sealing test shall be carried out after climatic endurance and storage tests.

APPENDIX A

(*Clause* 6.1.6.1)

SEQUENCE OF TYPE TESTS

All 15 Samples
|
Visual Examination
|
Dimensions
|
Applicable Electrical Tests (**6.2**)

- 3 Samples
  - Hermetic sealing
  - Soldering
  - Robustness of terminations
  - Bump
  - Vibration
  - Acceleration
  - Shock
  - Climatic sequence
  - Rapid change of temperature
  - Salt mist
- 3 Samples
  - Mould growth
- 3 Samples
  - Damp heat (long term exposure)
- 3 Samples
  - Endurance
- 3 Samples
  - Storage

AMENDMENT NO. 1 AUGUST 1973

TO

IS : 6297 (PART I) - 1971 SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

Alterations

(*Page* 1, *composition of* ETDC 38, *line* 7, *under* ‘ *Members* ’) — Substitute ‘ SHRI ISHWAR DUTT (*Alternate*) ’ *for* ‘ SHRI SURJIT SINGH (*Alternate*) ’.

(*Page* 7, *clause* **6.1.6.1**, *para* 2, *second line*) – Substitute ‘ 12 *fo* ‘ 15 ’.

(*Page* 17, *clauses* **6.3.6** *and* **6.3.7**, *second paragraphs*, *last sentence*) — Delete.

[*Page* 21, *Note under* **6.8** (c), *lines* 3 *and* 4] — Substitute ‘ climatic and endurance ’ *for* ‘ climatic, endurance and storage ’.

(*Page* 21, *Appendix A*)

a) *First line* — Substitute ‘ All 12 Samples ’ *for* ‘ All 15 Samples ’.

b) *Col* 5, *under* ‘ *Applicable Electrical Tests* (**6.2**) ’ — Delete.

(ETDC 38)

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AMENDMENT NO. 2 JULY 1975

TO

IS : 6297 (Part I)-1971 SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

Addenda

(*Page* 10, *clause* **6.2.1.7**, *second paragraph*) — Add the following matter after the second paragraph:

' The limiting current for the test equipment shall not exceed 2 mA for transformers upto 2 kVA power rating. However, any other current may be agreed upon between the manufacturer and the purchaser for transformers whose output voltage is greater than 2 800 V peak or the power rating is higher than 2 kVA. The value of the limiting current shall be included in the test report. '

(*Page* 12, *clause* **6.2.3.2**) — Add the following new clause after **6.2.3.2** and re-number the subsequent clauses and figures accordingly wherever they appear:

' **6.2.3.3** *Centre tap balance test* (*for centre tapped winding*) — The balance of centre tapped winding shall be checked by connecting the transformer as shown in Fig. 2.

The resistor r shall be adjusted until voltage V across the load R^L goes through minimum. The limits shall be as specified when calculated from the formula:

$$\text{Change of voltage in d}B = 20 \log_{10} \frac{R}{r-R} \text{ ,}$$

(ETDC 38)

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AMENDMENT NO. 3   MAY 1976
TO
IS : 6297 (Part I)-1971 SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART I GENERAL REQUIREMENTS AND TESTS

(This supersedes Amendment No. 2)

Addenda

(*Page* 10, *clause* **6.2.1.7**, *second paragraph*) — Add the following after the second paragraph:

'The limiting current for the test equipment shall not exceed 2 mA for transformers up to 2 kVA power rating. However, for transformers whose output voltage is greater than 2 800 V peak or the power rating is higher than 2 kVA, any other current value may be agreed upon between the manufacturer and the purchaser.

The value of the limiting current shall be included in the test report.'

(*Page* 12, *clause* **6.2.3.2**) — Add the following new clause after **6.2.3.2** and re-number the subsequent clauses and figures accordingly wherever they appear:

6.2.3.3 *Centre tap balance test* (*for centre tapped winding*) — The balance of centre tapped winding shall be checked by connecting the transformer as shown in Fig. 2.

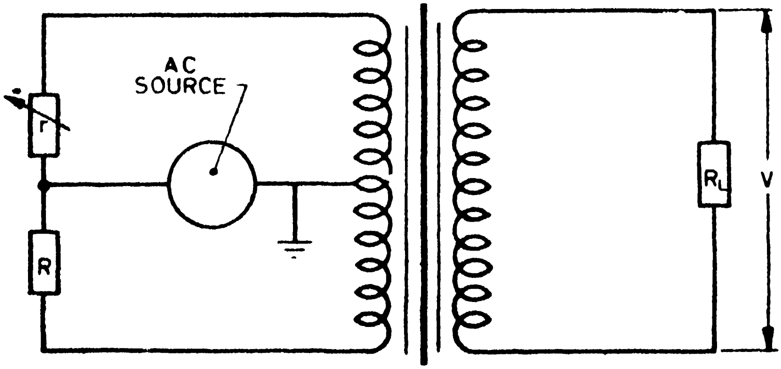

Fig. 2 Arrangement for Centre Tap Balance Test

The resistor r shall be adjusted until voltage V across the load R_L goes through minimum. The limits shall be as specified when calculated from the formula:

$$\text{Change of voltage in } dB = 20 \log_{10} \frac{R}{r - R}$$

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PART I GENERAL REQUIREMENTS AND TESTS

Alteration

(*Page* 6, *clause* **4.4**) — Substitute the following for the existing clause:

' **4.4 Finish** — All exposed metal parts such as edges of laminations, brackets and other hardware shall be plated, painted or otherwise protected to prevent corrosion. The transformers shall be given a suitable finish by impregnation, moulding and hermetic sealing as required. '

(LTDC 8)

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